GENERAL PERFORMANCE SPECIFICATION

FOR THE

COMMON MODULAR POWER SYSTEM

Draft Version 0.10
29 October 2007
(CMPS Perf Spec v10.doc)

Prepared for:

PEO GCS

Prepared by:

CMPS IPT

Version	Date	Summary of Changes
D0.1	6 December 2005	Initial draft release for CMPS IPT review
D0.2	17 January 2007	Updates from CMPS spec discussion meetings
D0.3	1 February 2007	Updates from CMPS spec discussion meetings
D0.5	5 February 2007	Updates from CMPS spec discussion meetings
D0.7	28 February 2007	Updates from CMPS spec discussion meetings
D0.9	20 August 20, 2007	Updates from CMPS Stryker Phase III SRR

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
20 AUG 2007	**N/A**	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
General Performance Specification for the Common Modular Power System, Draft Version 0.10 (CMPS Perf Spec v10.doc)	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **USATACOM 6501 E 11 Mile Road Warren, MI 48397-5000**	8. PERFORMING ORGANIZATION REPORT NUMBER **18440**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) **TACOM TARDEC**	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited.

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**29**	

1 SCOPE

1.1 Identification

This specification establishes basic system-level performance requirements for the Common Modular Power System (CMPS). This specification is intended to be used in conjunction with a vehicle specific performance specification to define the requirements of the CMPS as applied to the PEO GCS platforms. This specification is to be used to write the specific CMPS vehicle specification, choosing the requirements from this specification that would be applicable to the specific vehicle integration.

1.2 System overview

The purpose of the CMPS is to meet the following objectives.

- Provide sufficient electrical power for PEO GCS systems current and future needs
- Provide power management capabilities to the PEO GCS platforms
- Increase commonality of CMPS hardware between vehicles
- Provide energy to meet silent operational requirements
- Use an open architecture

1.3 Definitions

TBD

1.4 Document overview

This document conforms to the format and content preparation instructions of Data Item Description (DID) DI-SDMP-81465A, Performance Specification Documents and MIL-STD-961, Defense and Program-Unique Specifications Format and Content.

Section 1 identifies the CMPS and provides a brief overview.

Section 2 provides a list of documents referenced in the body of this specification.

Section 3 specifies the system level performance requirements for the CMPS.

Section 4 specifies the verification method(s) for each requirement of Section 3.

Section 5 specifies packaging requirements for the CMPS.

Section 6 contains a list of acronyms and abbreviations used in this specification.

2 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered the superseding requirement.

2.1 Government documents

SPECIFICATIONS:

Federal

Military

Other Government Agency

STANAG No. 2601	Standardization of Electrical Systems in Tactical Land Vehicles

STANDARDS:

Federal

Military

MIL-STD-704F	Aircraft Electric Power Characteristics
MIL-STD-1275D	Characteristics Of 28 Volt DC Electrical Systems In Military Vehicles
MIL-STD-810F	Environmental Engineering Considerations And Laboratory Tests
MIL-STD-1332B	Definitions Of Tactical, Prime, Precise, And Utility Terminologies For Classification Of The DoD Mobile Electric Power Engine Generator Set Family
MIL-STD-1472F	Human Engineering
MIL-STD-1474D	Noise Limits
MIL-STD-882D	Standard Practice For System Safety
MIL-STD-461E	Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems And Equipment
MIL-STD-464A	Electromagnetic Environmental Effects Requirements For Systems
MEP-STD-001	Export Power, Vehicle Mounted, Tactical, Alternating Current Up To 30 Kilowatts

Other Government Agency

FCS 786-32099	High Voltage Electric Power Characteristics
FCS 786-0000102150	Power Management API Specification

DRAWINGS:

OTHER PUBLICATIONS:

Manuals

Regulations

Handbooks

MIL-HDBK-759C	Handbook For Human Engineering Design Guidelines

Bulletins

Miscellaneous

TARDEC Registration Number 16974 DI-SDMP-81465A 1 August 2003	Vehicle Electronics (Vetronics) Power And Grounding Design Guidelines Data Item Description (DID), Performance Specification Documents

2.2 Non-Government documents

SPECIFICATIONS:

STANDARDS:

ISO 11898	Road vehicles -- Controller area network (CAN)

DRAWINGS:

OTHER PUBLICATIONS:

NFPA 70(05)SB	National Electric Code

3 REQUIREMENTS

3.1 First article

When specified in contract or purchase order, samples shall be subjected to first article inspection.

3.2 Design, materials, and manufacturing processes

Unless otherwise specified, the design, materials, and manufacturing process is the prerogative of the contractor as long as all articles submitted to the government fully meet the operating, interface, ownership and support, and operating environment requirements.

No radioactive or asbestos materials shall be used in the manufacture or assembly of the CMPS such that any part of any component retains any of these materials, excluding GFE.

No ozone-depleting substances shall be used in the manufacture, assembly, or are required for the sustainment of the CMPS.

3.3 Operating requirements

The purpose of the CMPS is to provide a common electrical architecture using a common approach for implementing electrical improvements for all PEO GCS vehicle systems. The operating requirements are not intended to be an all or nothing solution, but a modular implementation where vehicles can apply the technologies they need when they need them. However, if any of the below areas are targeted for improvement, the PEO GCS vehicles are expected to use the below requirements.

The CMPS includes:

- Electrical Power Generation
- Electrical Voltage Conversion
- Electrical Energy Storage
- Electrical Power Distribution
- Electrical Power Management
- Power Management Data Network
- Vehicle Interface Requirements
- Thermal Management Requirements

3.3.1 General

The CMPS current interrupting devices shall be able to open the circuit without any damage to itself or other circuits.

The CMPS components shall conform to Vehicle Electronics Power and Grounding Design Guidelines (Registration Number 16974).

High power low voltage electric loads (greater than 840 watts) shall be considered for migration to the high voltage bus.

The CMPS shall be designed and manufactured to comply with High Voltage Corona (HVC) prevention, utilizing MIL-HDBK454, Guideline 45 for altitudes up to 15,000 feet.

Above 15,000 ft. above sea-level, CMPS operation shall not require the use of high voltage.

3.3.2 Electrical Power Generation

High voltage electrical power shall be generated in accordance with FCS standard 786-30299, for High Voltage DC Bus (Type I Power).

Low voltage electrical power shall be generated at 28VDC in accordance with MIL-STD-704F, section 5.3.2 28 volts DC system.

The electrical power generation, derived from the prime mover, shall provide electrical power without causing the prime mover to operate outside of its specified operating conditions.

Non-primary Power System (NPS) shall conform to the NPS specification, Appendix A.

The electrical power generator shall output at least TBD% of generator power rating at tactical engine idle.

3.3.3 Electrical Voltage Conversion

3.3.3.1 General Electrical Voltage Conversion Requirements

High-voltage to Low-voltage electrical power converters shall have at least 2500V galvanic separation between high voltage and low voltage inputs and outputs.

High voltage inputs to power converters shall be compatible with FCS 786-30299, for High Voltage DC Bus (Type I Power).

All electrical voltage converters shall have reverse polarity protection when converting power in either direction.

All electrical voltage converters shall have a minimum converter efficiency of 90% at normal rated converter output power in the direction of normal operation.

All electrical voltage converters shall be able to communicate using the power management data network, per section 3.3.8.

Electrical voltage converters shall be sized to allow for vehicle start from either onboard energy storage or external electrical power.

Electric power converter shall have specific power of at least TBD W/kg and power density of TBD W/liter when converting in either direction.

3.3.3.2 Alternating Current Voltage Converters

The vehicle shall be able to export/import three-phase 208 and 110 VAC in accordance with MIL-STD-1332B, Type 1 – Tactical, Class II – Utility, Mode I.

The vehicle shall be able to convert three phase 110/208VAC to high voltage DC and high voltage DC to 110/208VAC, using the same bi-directional converter, through shore power interface (MIL-STD-xxxx, section yyy).

3.3.3.3 DC to DC Voltage Converters

Bi-directional DC to DC voltage converters shall be able to convert from 610 VDC to 28 VDC and convert from 28 VDC to 610 VDC.

DC to DC power converters shall be either ~5kW or ~10 kW module(s).

DC to DC converters shall be designed to withstand peak transient load conditions of TBD% of rated maximum steady state power load for TBD seconds.

3.3.4 Power distribution

3.3.4.1 General Requirements

The power distribution subsystem shall be able to distribute 28 VDC power to 28 VDC loads.

The power distribution subsystem shall be able to distribute 610 VDC power to 610 VDC loads.

The power distribution subsystem shall be able to control load circuit engagement (Off/On) to all vehicle electrical loads.

The power distribution subsystem shall be able to provide Pulse Width Modulation (PWM) control of required vehicle electrical loads.

The power distribution subsystem shall protect loads from over-voltage, under-voltage, over-current, and reverse polarity conditions.

The power distribution subsystem shall monitor and report load voltage, load current, and temperature at the control device.

The power distribution subsystem shall provide ground fault protection.

The power distribution subsystem shall provide short protection.

The power distribution subsystem shall provide arc fault protection.

The power distribution subsystem shall use standard military grade connectors for interfaces.

The power distribution subsystem shall provide protection to the operators and maintainers against electric shock.

The power distribution subsystem shall communicate through the power management data network, per section 3.3.8.

The power distribution subsystem shall be controlled through the power management data network, per section 3.3.8.

The power distribution subsystem load controllers shall be programmable to match each load's requirements.

The power distribution subsystem controllers shall prevent sympathetic tripping. The cause of sympathetic tripping is a circuit false tripping condition caused by bus transients and EMI affecting the electronics in a power controller so that it does not function and turns off the load circuit that it controls.

3.3.4.2 Low Voltage Distribution

The low voltage power distribution subsystem shall be compatible with both MIL-STD-1275D and MIL-STD-704F power quality for low voltage distribution.

The low voltage power distribution subsystem shall be grounded with a single point ground in accordance with Vehicle Electronics Power and Grounding Design Guidelines (Registration Number 16974).

The low voltage power distribution subsystem shall separate clean and dirty loads. Clean loads will be MIL-STD-704F compatible loads and dirty loads will be those that do not meet MIL-STD-704F, but that do meet MIL-STD-1275D.

The low voltage power distribution subsystem shall maximize the use of point of load power distribution.

3.3.4.3 High Voltage Distribution

The high voltage power distribution subsystem shall be compatible with FCS 786-30299 power quality for Type I Power, high voltage distribution.

The high voltage power distribution subsystem shall incorporate safety features (e.g. interlocks) as required for high voltage power distribution.

3.3.5 Power management

The CMPS shall comply with the Power Management Application Program Interface (FCS Document 786-0000102150).

The CMPS shall manage electrical power distribution, utilization, and monitor and protect the power system and loads.

The CMPS shall monitor the power usage of each load and report it to the vehicle power management system.

The CMPS shall control the state of each load based on a priority system, programmable by the OEM and/or the crew.

The CMPS shall be capable of controlling and monitoring power distribution controllers.

The CMPS shall be capable of dynamic load prioritization and load shedding.

The CMPS shall provide host vehicle electrical system status information to the crew and maintenance personnel. The status information shall include electrical faults or problems, battery charge, battery life remaining at present load, battery pack health, alternator health, and alternator current output.

3.3.5.1 Battery Management

Battery management shall be able to communicate over the power management data network, per section 3.3.8.

Battery management shall calculate and report time remaining before batteries are 0% usable State Of Charge (SOC), based on current power usage rates.

Battery management shall calculate and report time remaining before vehicle can no longer be started, based on current power usage rates.

Battery management shall calculate and report time remaining before batteries are charged. Lead-acid batteries are considered charged when they will only accept current at a rate less than 3 amperes at the appropriate charging voltage.

Battery management shall provide SOC for each battery. SOC will be for each series battery pair if batteries are in a series configuration.

Battery management shall provide state of health of each battery. State of health identifies how much of the useful battery life has passed and if the battery needs to be replaced with an accuracy of 90%.

Battery management shall learn SOC and state of health characteristics of battery newly introduced to the system within two discharge cycles.

Battery charging shall be optimized for maximum battery life for the type of energy storage present on the vehicle.

Battery charging shall provide battery equalization to balance the SOC between each battery in a series configuration.

3.3.6 Energy storage

Energy storage shall be sufficient to start the vehicle at ambient temperatures ranging from +50 to -46 degrees Celsius. For ambient temperatures below -25 degrees Celsius, special provisions may be used to meet this requirement.

Energy storage shall be able to operate vehicle systems with the main engine off.

All primary vehicle batteries shall conform to 6TMF size, venting and terminal placement.

3.3.7 Thermal management requirements

TBD

3.3.8 Power Management Data Network

The power management data network shall be Dual Controller Area Network (CAN) bus controller (SAE J-1939/ISO 11898) protocol.

The power management data network shall use copper wire as the physical medium.

The power management data network shall operate at a bandwidth of 1Mb/s for the primary network.

The power management data network shall operate at a bandwidth compliant with the engine and transmission subsystems for the secondary network.

3.3.9 Vehicle interface requirements

3.3.9.1 NATO Slave Interface

The vehicle shall be equipped with a standard NATO slave interface as defined by STANAG No. 2601.

All vehicles shall have an isolated MIL-STD-1275D electrical bus separate from the low voltage electronics power bus. This isolated low voltage bus shall be able to interconnect with the low voltage electronics bus in emergency situations.

The NATO slave interface shall support:

a) Recharging of all energy storage on the vehicle
b) MIL-STD-1275D electrical power input into the host vehicle
c) “Slave” starting the host or another vehicle
d) Outputting 28VDC electrical power to another vehicle

3.3.9.2 High Voltage Vehicle to Vehicle Interface

The CMPS adapted vehicle shall be able to import/export TBD kW 610VDC electrical power.

3.3.9.3 Exporting electrical power

The CMPS adapted vehicle shall be capable of exporting TBD kW to power more than one additional vehicle through the export interfaces.

3.4 Ownership and support requirements

3.4.1 Reliability

The CMPS shall not reduce the pre-CMPS vehicle’s reliability.

3.4.2 Maintainability

The CMPS shall be designed for ease of maintenance and repair by using Line Replacement Units (LRUs)/Line Replacement Modules (LRMs) and Shop Replacement Units (SRUs). LRUs/LRMs are defined as any part or component that is replaceable by field maintenance personnel. SRUs are defined as any part or component that is replaceable at a repair center or depot.

The CMPS shall incorporate both embedded prognostics and embedded diagnostics that detect and isolate faults to the individual LRU/LRM/SRU level.

Prognostics and diagnostics shall provide the level of detection and isolation required to meet the stated reliability requirements.

The use of stand-alone test equipment shall be minimized.

The use of embedded prognostics and diagnostics shall be maximized.

The CMPS design shall minimize the number of distinct electrical connectors interfacing with internal LRUs/LRMs and the vehicle host platform.

Electrical and electronic connectors to be used within the CMPS shall be “keyed” or provide mechanical measures to help prevent improper mating with the proper LRU/LRM.

3.4.2.1 Prognostics

The CMPS will provide data that can be used to perform prognostic functions.

3.4.2.2 Diagnostics

The CMPS shall incorporate embedded diagnostics that can detect 99% of all detectable failures/faults with no more than 5% error rate (false alarm or missed failures/faults).

The diagnostics shall be able to isolate:

a) To one LRU/LRM 95%, ambiguity group of 1
b) To two or less LRUs/LRMs 97%, ambiguity group of 2
c) To three or less LRUs/LRMs 99 %, ambiguity group of 3

3.4.3 Weight

The weight of the CMPS shall be consistent with the weight constraints of the host vehicle.

3.4.4 Dimensions

The physical dimensions of the CMPS shall be consistent with the available mounting space for power generation and distribution components within the host vehicle.

3.4.5 Manpower and personnel integration

3.4.5.1 Manpower

The CMPS shall not require any increase in crew or maintenance manpower.

3.4.5.2 Personnel

The CMPS shall be designed such that it can be operated, maintained and sustained by 5^{th} - 95^{th} percent of the targeted male and female soldier population, from the appropriate target audience, with all mission-appropriate uniform and ensemble configurations, in all environmental conditions.

The CMPS shall not present any uncontrolled safety or health hazards to operators, maintainers, and support personnel during the lifecycle of the system using MIL-STD-1472 and MIL-STD-1474 as guides.

3.4.5.3 Human factors

The CMPS equipment shall promote ease of operation and utilize controls and displays that are easy to understand and readily accessible using MIL-STD-1472 and MIL-HDBK-759 as guides.

3.4.5.4 Training

The CMPS shall be capable of supporting embedded training, including mission planning and rehearsal.

3.4.5.5 Safety requirements

CMPS equipment shall meet the applicable requirements of the National Electrical Code, NFPA 70-05, sections TBD.

The system shall provide protection to the operators and maintainers against electric shock.

The CMPS shall not have any uncontrolled safety or health hazards (including noise, excessive heat, and toxic fumes) that may adversely impact upon the health or safety of the operator, maintainer, trainer, or handler.

Priority shall be given to eliminating or reducing, to an acceptable level of risk, hazards through design considerations with the use of Warnings, Cautions, and Alerts (WCAs) as a last resort.

Emergency controls shall be easily identifiable.

Emergency controls shall provide clear indication of the appropriate action required in the event of an emergency. MIL-STD-882 shall be used as a guide.

Reverse polarity protection must be employed at the system level.

3.4.5.6 Warnings, cautions and alerts

The CMPS shall have the capability to automatically generate Warnings, Cautions, and Alerts (WCAs) when conditions warrant.

WCAs shall be defined as follows:

a) Warnings – a condition that could result in death or injury to personnel
b) Cautions – a condition that could result in damage to the equipment
c) Alerts – a condition that the vehicle crew should be made aware

Warnings shall take priority over Cautions and Alerts.

Cautions shall take priority over Alerts.

WCAs shall be capable of generating audible and/or visual alarms.

The current status of all WCAs shall be included in the CMPS data log.

3.4.5.7 Noise levels

The CMPS shall meet host vehicle audible noise level requirements.

3.4.5.8 Security and privacy requirements

The CMPS shall comply with the host vehicle's requirements for information assurance.

3.4.6 Transportability

The CMPS shall support host vehicle requirements for transportability.

3.5 Operating environmental requirements

The operating environment of the CMPS shall be consistent with the operating environment constraints of the host vehicle.

Temperature

The CMPS shall operate in ambient temperatures ranging from -35 to +140 degrees Fahrenheit (-37 to +60 degrees Centigrade).

The CMPS shall survive extended storage periods in ambient temperatures ranging from –50 to +160 degrees Fahrenheit (-46 to +71 degrees Centigrade).

The use of winterization kits is permissible to support operations below -25 degrees Fahrenheit (-32 degrees Centigrade).

Thermal shock

TBD

Solar radiation

TBD

Humidity

The CMPS shall be capable of operation and storage while being exposed to 0 to 100% relative humidity.

Shock

The CMPS shall be capable of withstanding high levels of induced shock encountered during various modes of operation and transport including traversing difficult cross country terrain, and transport on fixed wing aircraft.

The CMPS shall withstand the rail impact test specified in MIL-STD-810 without degradation or damage.

Vibration

The CMPS shall operate without performance degradation or damage from the effects of vibration during the conduct of a mission or during transport.

Altitude

The CMPS shall be capable of withstanding, without preparation or any degradation in performance, the altitude requirements of MIL-STD-810.

The CMPS shall be capable of storage and operation at “cabin” altitudes up to 15,000 feet or 8.3 psia as per MIL-STD-810.

Rain

TBD

Salt fog

The CMPS shall operate without performance degradation during and after exposure to a salt fog concentration of 5±1 percent for 48 hours as per MIL-STD-810.

Sand

TBD

Dust

TBD

Fungus

TBD

Chemical, biological, radiological and nuclear

The CMPS shall be hardened against the material damaging effects of Chemical, Biological, Radiological, and Nuclear (CBRN) and chemical/toxic industrial material contaminants and decontaminants.

The CMPS shall survive initial nuclear radiation (INR), blast, thermal effects such that all essential mission functions are operational within the host vehicle initialization times.

Electromagnetic environment effects

EMI/EMC

The CMPS shall be Electromagnetic Compatible (EMC) and must not cause disruptive EMI or be susceptible to EMI (per MIL-STD-461 and MIL-STD-464) nor post a hazard to any existing or proposed ordnance system.

HEMP

The CMPS shall be able to support critical mission functions of the host vehicle while in NBC contaminated environments and within 15 minutes following High-altitude Electromagnetic Pulse Environments (HEMP).

Grounding, bonding and shielding

3.5.1 Grounding, bonding, and shielding

CMPS electrical and electronic equipment enclosures shall be grounded to the vehicle structure.

Electrical harnesses shall contain an overall shield bonded to the backshell of each harness connector.

All design components that include sensitive electronics elements shall include appropriate enclosures, bonding and grounding to protect them from Electro-Static Discharge (ESD) from human contact.

The CMPS shall support the guidelines published in Vehicle Electronics Power and Grounding Design Guidelines (Registration Number 16974).

3.6 Other requirements

None.

3.7 Precedence and criticality of requirements

All the requirements of this specification have equal precedence and criticality.

4 VERIFICATION

4.1 Methods of verification

Methods utilized to accomplish verification include:

a) Analysis: An element of verification that utilizes established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures to provide evidence that stated requirements were met.

b) Demonstration: An element of verification which generally denotes the actual operation, adjustment, or re-configuration of items to provide evidence that the designed functions were accomplished under specific scenarios. The items may be instrumented and quantitative limits of performance monitored.

c) Examination: An element of verification and inspection consisting of investigation, without the use of special laboratory appliances or procedures, of items to determine conformance to those specified requirements which can be determined by such investigations. Examination is generally nondestructive and typically includes the use of sight, hearing, smell, touch, and taste; simple physical manipulation; mechanical and electrical gauging and measurement; and other forms of investigation.

d) Test: An element of verification and inspection which generally denotes the determination, by technical means, of the properties or elements of items, including functional operation, and involves the application of established scientific principles and procedures.

4.2 Classification of verifications

The classification of verification requirements are:

a) Production Qualification Test/Operational Test (PQT/OT).

b) First Article Test (FAT).

c) Conformance Acceptance Test (CAT).

Failure of any assembly, device, component, or test specimen to meet any of the requirements is cause for rejection. The Government reserves the right to terminate verification upon any failure to meet any of the requirements.

4.3 Verifications

Test samples may undergo to any or all of the tests listed in Table 4.3-1 and verified for compliance with any or all of the requirements of the CMPS performance specification.

Table 4.3-1 Requirements Verification Cross-Reference Table

Method of Verification
A-Analysis
D-Demonstration
E-Examination
T-Test

Paragraph	Requirement	Verification Method				Classification		
		A	D	E	T	PQT/OT	FAT	CAT
3	REQUIREMENTS							
3.1	First article							
3.2	Design, materials, and manufacturing processes							
3.3	Operating requirements							
3.4	Interface requirements							
3.5	Ownership and support requirements							
3.6	Operating environmental requirements							

4.4 Basis for Acceptance

Test samples shall meet all test and verification criteria.

5 PACKAGING

5.1 General

For acquisition purposes, the contract or order shall specify packaging requirements. When DOD personnel perform material packaging, those personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. The Inventory Control Point packaging activity within the Military Department of Defense Agency, or within the Military Department's System Command, maintains packaging requirements. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6 NOTES

6.1 Acronyms and abbreviations

AC	Alternating Current
APU	Auxiliary Power Unit
BIT	Built-In Test
BITE	Built-In Test Equipment
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAN	Controller Area Network
CBRN	Chemical, Biological, Radiological, and Nuclear
COP	Common Operating Picture
DC	Direct Current
DID	Data Item Description
DoD	Department of Defense
EA	Electronic Architecture
EFF	Essential Function Failures
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMPRS	En-route Mission Planning and Rehearsal System
ESD	Electro-Static Discharge
FCS	Future Combat Systems
GFE	Government Furnished Equipment
HDBK	Handbook
HEMP	High-altitude Electromagnetic Pulse
IAW	In Accordance With
INR	Initial Nuclear Radiation
IPT	Integrated Product Team
ISA	Integrated Starter/Alternator
ISO	International Standards Organization
LDSS	Logistics Decision Support System
LRM	Line Replacement Module
LRU	Line Replacement Unit
MDL	Mission Data Loader
MGV	Manned Ground Vehicle
MIL	Military
MMH	Maintenance Mean Hours
MOPP	Mission Oriented Protective Posture
MR	Maintenance Ratio
MTBEFF	Mean Time Between Essential Function Failure
MTBSA	Mean Time Between System Abort
MTBSA-M	Mean Time Between System Abort –Mobility
MTTR	Mean Time To Repair
N/A	Not Applicable

NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological and Chemical
NEFF	Non- Essential Function Failures
OH	Operating Hour
ORD	Operational Requirements Document
PMCS	Preventive Maintenance Checks and Services
RPC	Remote Power Controller
RPM	Revolutions Per Minute
SBCT	Stryker Brigade Combat Team
SRU	Shop Replacement Unit
STD	Standard
SW	Software
T&M	Test and Maintenance
TARDEC	TACOM Research Development and Engineering Center
TBD	To Be Determined
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current
Vetronics	Vehicle Electronics
VI-MREF	Vehicle Integrated - Multi-service Regenerative Electrolyzer Fuel cell
W	Watts
WCA	Warnings, Cautions, and Alerts

7 APPENDIX A – Non-primary Power System Requirements

7.1 Operational requirements

The NPS shall operate in ambient air temperatures of -46C to +52C. The NPS compartment will have temperatures of -46C to +75C.

The NPS shall be capable of providing 8kW (required) – 10kW (desired) continuous electrical draw for 12 hours.

The NPS shall comply with MIL-STD-1275D for low voltage generation.

The NPS fuel consumption shall be no more than 21 gallons (required) – 18 gallons (desired) for 12 hours of operation.

The NPS will provide a CAN interface to report operational status (voltage, current, temperature, etc.) and diagnostics (BIT, operating hours, etc.) to the power management data network and the current vehicle diagnostics system.

If it requires fuel to operate, must use fuel (JP-8 primary) from the vehicle's fuel cell as the source.

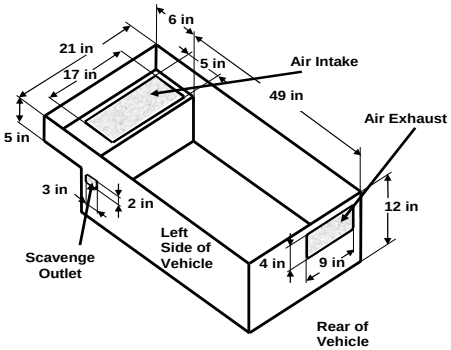
Fuel Stands

- MIL-T-83133
- VV-F-800E
- MIL-T-5624

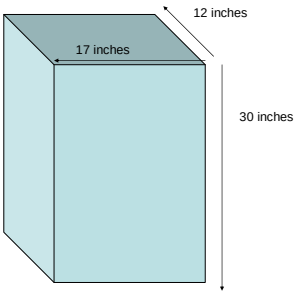
The NPS lubricant selection shall be in accordance with AR70-12.

The size of the NPS when integrated into the vehicle shall not exceed

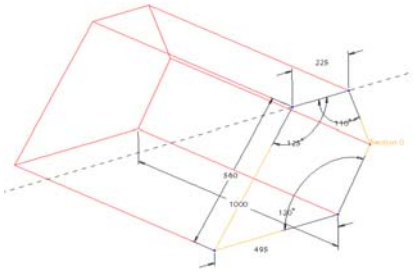
Abrams:



Bradley:



Stryker:



The weight of the NPS system integrated into

- Abrams must be less than 450 lbs, and will require its own cooling system, air filtration and exhaust system
- Bradley must be less than 450 lbs, and will require its own cooling system, air filtration and exhaust system
- Stryker must be less than 250 lbs and will require its own air filtration and exhaust system, but may use the main engine cooling system or provide its own

The NPS mean time between failures must be a minimum of 500 hours.

The NPS noise shall not exceed that of the main engine after vehicle integration.

7.2 Environmental requirements

The NPS shall be capable of operating without performance degradation during and after exposure to hot-humid conditions as per MIL-STD-810E, Method 507.3, Procedure II-3.3.

The NPS shall be capable of operating without power degradation up to elevations of 2000 feet, and with power degradation up to 10,000 feet.

The NPS shall be capable of operating without performance degradation during and after exposure to 1120 watts/m2 normal incident solar radiation at 49°C.

The NPS shall be capable of operating in heavy sand environments without performance degradation.

The NPS shall operate without performance degradation during and after exposure to blowing dust.

The NPS shall be capable of operating without degradation after exposure to heavy rainfall. During heavy rainfall, the NPS shall be capable of operating without damage or degradation.

The NPS shall operate without performance degradation during and after exposure to a salt fog concentration of 5±1 percent as per MIL-STD-810F, Method 509.4

The NPS shall operate during and after exposure to icing rain as per MIL-STD-810F, Method 521.2 for glazed ice up to 6mm thick.

The NPS shall operate without performance degradation or damage from the effects of vibration during conductance of mission or transport. The maximum shock allowed on the vehicle is:

NPS shall meet the performance requirements during and after exposure to peak half-sine wave shock impulses of 30 +/- 3 g, 11.0 +/-1.1 ms applied in each direction of three mutually perpendicular axes vertical, latitudinal, and longitudinal. See Figure 1.

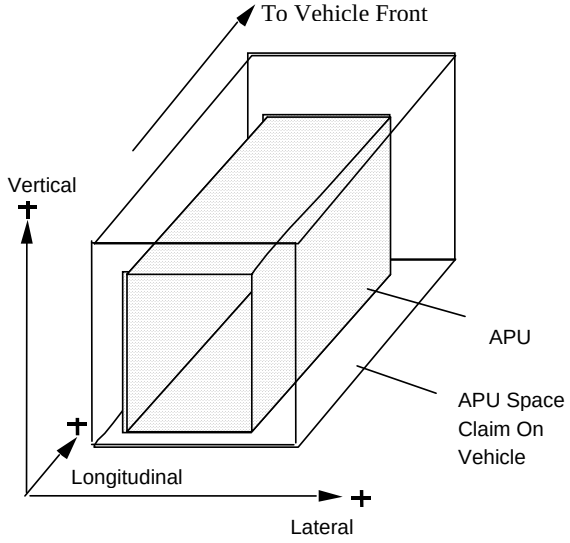


Figure 1

NPS shall meet the performance requirements during and after exposure to peak half-sine wave shock impulses, 55 g +/- 10% at 2.5 +/- 0.20 ms in each of three mutually perpendicular axes. See Figure 1

The NPS shall remain intact after exposure to shock impulses of 1.5x the magnitude of the Ballistic Shock Profile of Figure 2. A Ballistic Shock Equivalent Static Acceleration curve, Figure 3, indicates the shock envelope for the 1.5x Ballistic Shock Profile of Figure 2. Intact is defined as no leaks or separation of hardware. Deformation is allowed.

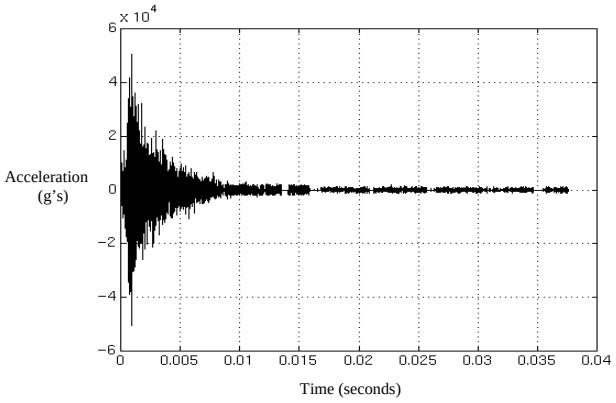


Figure 2. Ballistic Shock Profile

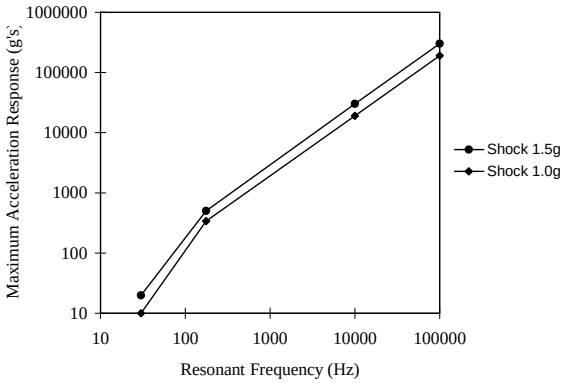


Figure 3. Ballistic Shock Equivalent Static Acceleration

Data points defined from Figure 3 are as follows:

Frequency (Hz)	(1.0) g's	(1.5) g's
30	10	20
175	340	500
10000	19000	30000
100000	190000	300000

The NPS shall meet the performance requirements during and after exposure to sinusoidal vibration in accordance with Table I in each of three mutually perpendicular axes. The vibration shall consist of logarithmic sweep rate of 15 minutes per sweep cycle from 5 Hz to 500 Hz to 5 Hz.

Table I. Vibration Levels

Axis	Frequency (Hz)	Amplitude
Vertical	5 to 25	1 g
	25 to 57	.03” DA
	57 to 500	5 g
Longitudinal and Lateral	5 to 25	1 g
	25 to 44	.03” DA
	44 to 500	3 g
Note: .03” DA indicates Double Amplitude, .03” deflection in opposite directions at .03” in each direction from a common center point.		

All components of the NPS shall be designed to be mutually compatible with other electronic equipment (CFE and GFE) within the vehicles’ expected operational electromagnetic environment. All spectrum dependent equipment must conform to the frequency spectrum certified for Army use worldwide.

All components that include sensitive electronics elements shall include appropriate enclosures, bonding and grounding to protect them from ESD from crew contact as specified in MIL STD 461.

Special Tools & Test Equipment (STTE) - All field level CNPS maintenance tasks (scheduled and unscheduled) and troubleshooting tasks shall be able to be completed using the tools contained in the General Mechanic's Tool Kit, Automotive (SC 5180-90-N26) or Artillery and Turret Mechanic's Tool Kit (SC 5180-95-A12) and a digital multimeter (note – Tool kit components can be viewed at https://weblog.logsa.army.mil/sko/electronic_skot.cfm?CD_RELEASE=SEP05. All operator level CNPS maintenance tasks (scheduled and unscheduled) shall be able to be completed using the tools contained in the platform's Basic Issue Items (BII) listed in the platform operator TM.

Scheduled Services - The scheduled service requirement for the CNPS shall not require removal of the CNPS, to include the associated Vehicle Unique Integration Kit, for mandatory inspections and services more than once per year (annually).